

Alcohol Screening Scores and Medication Nonadherence

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Background: Medication nonadherence is common and is associated with adverse outcomes. Alcohol misuse may be a risk factor for nonadherence; however, evidence is limited.

Objective: To identify whether alcohol misuse, as identified by a simple screening tool, is associated in a dose–response manner with increased risk for medication nonadherence in veterans attending primary care clinics.

Design: Secondary analysis of cohort data collected prospectively from 1997 to 2000 as part of a randomized, controlled trial.

Setting: 7 Veterans Affairs primary care clinics.

Participants: 5473 patients taking a statin, 3468 patients taking oral hypoglycemic agents, and 13 729 patients taking antihypertensive medications.

Measurements: Patients completed the Alcohol Use Disorder Identification Test–Consumption (AUDIT-C) questionnaire, a validated 3-question alcohol misuse screening test. Their scores were categorized into nondrinkers; low-level alcohol use; and mild, moderate, and severe alcohol misuse. Medication adherence, defined as having medications available for at least 80% of the observation days, was measured from pharmacy records for either 90 days or 1 year after the alcohol screening date. Logistic regression was used to estimate the predicted proportions of adherent patients in each

AUDIT-C group and adjusted for demographic and clinical covariates.

Results: The proportion of patients treated for hypertension and hyperlipidemia who were nonadherent increased with higher AUDIT-C scores. For 1-year adherence to statins, the percentage of adherent patients was lower in the 2 highest alcohol misuse groups (adjusted percentage of adherent patients, 58% [95% CI, 52% to 65%] and 55% [CI, 47% to 63%]) than in the nondrinker group (66% [CI, 64% to 68%]). For 1-year adherence to antihypertensive regimens, the percentage of adherent patients was lower in the 3 highest alcohol misuse groups (adjusted percentage of adherent patients, 61% [CI, 58% to 64%]; 60% [CI, 56% to 63%]; and 56% [CI, 52% to 60%]) than in the nondrinker group (64% [CI, 63% to 65%]). No statistically significant differences were observed for oral hypoglycemics in adjusted analyses.

Limitation: This observational study cannot address whether changes in drinking lead to changes in adherence and may not be generalizable to other populations.

Conclusion: Alcohol misuse, as measured by a brief screening questionnaire, was associated with increased risk for medication nonadherence.

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Daily medications are the cornerstone of chronic disease management. Medications to treat hypertension, hyperlipidemia, and diabetes—potent risk factors for cardiovascular disease—are common and are often prescribed for asymptomatic patients to prevent future disease. However, nonadherence to medications is common (1) and is associated with poor outcomes, increased health care costs (2, 3), and death (4). Many studies have examined patient characteristics associated with nonadherence, but most identified risk factors for nonadherence are not modifiable.

Alcohol misuse is common, has been associated with medication nonadherence, and is modifiable (5–7). However, research on alcohol misuse and medication adherence has been largely limited to patients with HIV (8–11) and a few studies of diabetes (3, 12, 13). One recent study found both a temporal and a dose–response relationship between alcohol consumption and medication adherence (8) but used a lengthy interview measure of alcohol use that is not practical for busy clinical settings. Therefore, it remains unclear whether brief validated alcohol screening questionnaires used in clinical practice could identify patients at risk for nonadherence due to alcohol misuse.

We examined whether primary care outpatient scores on a brief, scaled, alcohol screening questionnaire—the Alcohol Use Disorder Identification Test–Consumption (AUDIT-C)—were associated with medication nonadher-

ence. Specifically, we evaluated the association between increasing scores on the AUDIT-C (score range, 0 to 12) and adherence to oral medications commonly used for hypertension, hyperlipidemia, and diabetes. We hypothesized that higher AUDIT-C scores would be associated with an increased risk for medication nonadherence.

METHODS

Participants and Setting

We used data collected from the Ambulatory Care Quality Improvement Project (ACQUIP) cohort in this study (14). In brief, ACQUIP enrolled 36 821 active patients from the general internal medicine clinics of 7 Veterans Affairs (VA) medical centers nationwide, including facilities in Seattle, Washington; West Los Angeles, Cali-

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Context

Is alcohol misuse associated with medication nonadherence?

Contribution

This study of primary care patients attending 7 Veterans Affairs clinics found a graded, linear decrease in adherence to statins and hypertension medications with increasing levels of alcohol misuse.

Caution

Alcohol misuse was measured with a brief screening questionnaire that was mailed to patients. Adherence was measured by pharmacy refills.

Implication

Alcohol misuse may be associated with increased risk for medication nonadherence.

—The Editors

fornia; Birmingham, Alabama; Little Rock, Arkansas; San Francisco, California; Richmond, Virginia; and White River Junction, Vermont. The ACQUIP initially surveyed all VA sites and selected these 7 sites (from 60 respondents) on the basis of geographic diversity; well-established systems for assigning patients to firms; and an experienced, interested investigator to lead the study.

The ACQUIP was a randomized trial testing the effect of an audit and feedback quality-improvement intervention; there was no detectable effect of the intervention on primary outcomes, including alcohol misuse (14). Patients were eligible for ACQUIP if they had at least 1 visit to a primary care facility in the past year and had a primary care provider. The ACQUIP sent questionnaires (ACQUIP Health Checklist) at enrollment (1997 to 2000), and the institutional review board considered participant response to the survey to be consent for study participation. The survey assessed demographic characteristics, alcohol misuse, other health behaviors, and psychiatric and medical conditions. Patients who did not respond were mailed up to 3 additional surveys. The date the survey was received by the study team was considered the index date for all participants. Survey data were linked to electronic records, including pharmacy, diagnosis, and death records. Participants who died during follow-up were excluded. The institutional review board at each participating VA site approved ACQUIP, and the University of Washington Division of Human Subjects approved the secondary analyses that we present in this article.

Pharmacy Data and Medication Cohorts

Pharmacy data were retrieved electronically as part of the ACQUIP protocol from December 1995 to May 2000. Each prescription filled generated 1 record containing the drug name, the quantity and date dispensed, and the num-

ber of days supplied. These data are nearly identical to national VA pharmacy data (15), which have been used in several studies of medication adherence and pharmacoepidemiology (16, 17).

We identified 3 nonexclusive cohorts of patients with increasing medication regimen complexity: a statin cohort, consisting of all patients prescribed a statin medication for hypercholesterolemia; an oral hypoglycemic cohort, with all patients who were prescribed either a sulfonylurea or metformin for blood glucose control; and a hypertension treatment cohort, consisting of all patients with self-reported hypertension who were prescribed at least 1 of 6 classes of antihypertensive drugs (α -blockers, angiotensin-converting enzyme inhibitors, β -blockers, calcium-channel blockers, thiazide-type diuretics, or nonthiazide diuretics) and a group consisting of other antihypertension medications usually used as fourth- or fifth-line agents (such as hydralazine). We considered patients medication “users” and included them in 1 of the cohorts if they received both 1 or more fills of the drug class within 2 years before the index date and 1 or more fills in the year after the index date. We used these criteria to minimize potential dropout bias by ensuring that patients were still engaged in care and obtaining medications from the VA. We excluded glitazones and angiotensin-receptor blockers from analyses because few patients were prescribed these medications, which were on a restricted formulary at the time of the study. In addition, we excluded patients in the oral hypoglycemic cohort if they had an active prescription for insulin other than neutral protamine Hagedorn, in order to remove patients who transitioned from oral medication to insulin during the study.

Alcohol Misuse and AUDIT-C

We assessed alcohol misuse with the AUDIT-C from the ACQUIP Health Checklist. The AUDIT-C assesses frequency and typical quantity of drinking during the past year, as well as the frequency of heavy episodic drinking (≥ 6 drinks per occasion) by using 3 questions (18). Each of the 3 questions is scored 0 to 4, for a total combined score of 0 to 12. The AUDIT-C is reliable (19) and has been validated as a screening test for the spectrum of alcohol misuse, including risky drinking and alcohol-use disorders on the basis of *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*, criteria (18, 20, 21). A score of 4 or more is considered positive for alcohol misuse in male VA patients, but the AUDIT-C score has also been shown to be a scaled measure of risk for alcohol-related symptoms (22) and medical complications often associated with alcohol misuse (23–26). To provide adequate precision in estimates and allow comparison with previous analyses (23, 24), we grouped AUDIT-C scores into 5 categories: nondrinkers (score, 0); low-level alcohol use (score range, 1 to 3); and mild (score range, 4 to 5), moderate (score range, 6 to 7), and severe (score range, 8 to 12) alcohol misuse.

Medication Adherence

We created an individual measure of refill adherence, which was previously validated within the VA and ACQUIP, for each patient and medication class. This measure is similar to a medication–possession ratio, and it accounts for overstocking and medication gaps, correlates better with physiologic outcomes when compared with previous measures, and is described in detail elsewhere (27). From this measure, we derived a proportion of days covered that reflected the number of days during the observation period that medication was available (17). We considered all medications within a medication type (statin, oral hypoglycemics, and antihypertensive medications) to be equivalent for purposes of adherence.

We calculated adherence separately for 2 different periods: 90 days and 1 year starting from the index date. We assessed at 1 year because it is a traditional measurement of adherence (16, 17). We also assessed at 90 days because refill adherence for this period has been correlated with outcomes (27).

On the basis of previous medication adherence literature (16, 17), we considered patients in all medication cohorts to be adherent if they had medication available for at least 80% of the observation period. In other words, for the 90-day observation period, nonadherent patients would not have medication available for at least 18 days; for the 1 year-period, they would be without medication for at least 73 days. When more than 1 medication was used (for example, for diabetes or hypertension), the proportions of days covered were averaged, and we considered patients to be adherent if they had at least 80% of the drug regimen for diabetes or hypertension available for the observation period. A person who met the definition of a user for 2 drug classes but only maintained complete fills of 1 drug with no fills of the other drug therefore would have an average adherence of 0.5 and would be considered nonadherent to the overall regimen.

Covariates

Race was based on a combination of self-report from the ACQUIP Health Checklist and the electronic record. We determined sex, education, and marital status from the ACQUIP Health Checklist. We calculated a drug count from the number of oral drugs that patients obtained during the year before the index date to adjust for total medication regimen complexity. We classified smoking status as current, former, or never. We assessed depression with the Mental Health Inventory (score range, 5 to 30); scores greater than 17 were positive for depression (28).

Statistical Analysis

We conducted analyses separately for each of the overlapping medication cohorts (ACQUIP participants taking statins, oral hypoglycemic agents, or antihypertensive agents). We did not do any formal power calculations for these analyses.

We present unadjusted descriptive statistics on the prevalence of covariates for each cohort, as well as the unadjusted prevalence of adherence within each of the 3 medication cohorts. Within each medication cohort, we used logistic regression to assess the association between AUDIT-C scores and medication adherence and produced adjusted percentages of adherent patients. We present adjusted proportions or percentages, rather than odds ratios, because they may be more clinically interpretable than odds ratios when the frequency of the outcomes is common and therefore do not approximate relative risks. We did analyses separately for 90-day and 1-year adherence periods. Although we hypothesized that increased screening scores would be associated with increased nonadherence a priori, we did not specify the exact nature of the relationship and modeled AUDIT-C categories as categorical (dummy) variables to allow for nonlinear effects. In all analyses, we used nondrinkers as the referent group. For each drug cohort, we examined 3 models, adding covariates in blocks: an unadjusted model, a demographic characteristic-adjusted model, and fully adjusted model that included smoking and depression screening scores. We specified models a priori on the basis of known associations between AUDIT-C scores and selected covariates (29). We adjusted the percentage of adherent patients in each AUDIT-C category to reflect the mean of each included covariate in the overall sample. We completed all analyses by using Stata Special Edition, version 9.2 (Stata, College Station, Texas) (30).

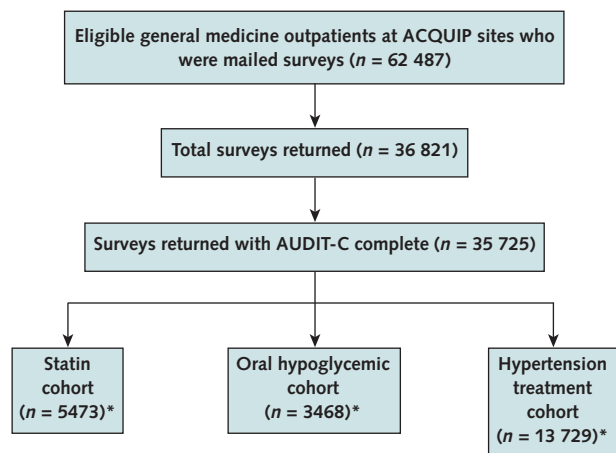
Role of the Funding Source

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RESULTS

Among the 35 725 primary care patients who participated in ACQUIP and returned an ACQUIP Health Checklist with a complete AUDIT-C, 5473 used a statin, 3468 used an oral hypoglycemic, and 13 729 used an antihypertensive medication (**Figure 1**). **Table 1** shows the demographic characteristics of the overlapping cohorts that reflect the VA primary care population, which tends to be older, white men. A higher proportion of oral hypoglycemic recipients were nondrinkers compared with statin or antihypertensive recipients, and approximately 20% of participants overall had AUDIT-C scores of 4 or more, signifying positive screenings for alcohol misuse.

Figure 1. Study flow diagram.



ACQUIP = Ambulatory Care Quality Improvement Project; AUDIT-C = Alcohol Use Disorder Identification Test–Consumption. * Drug cohorts are not mutually exclusive. Cohorts are defined as patients who received both 1 or more fills of the drug class within 2 years before the date on which the AUDIT-C was returned (index date) and 1 or more fills in the year after the index date.

Although no patient was prescribed more than 1 statin, in the oral hypoglycemic cohort, 78% were receiving monotherapy, whereas 22% took both a sulfonylurea and metformin. Approximately half the patients in the hypertension cohort (47%) were prescribed a single antihypertensive medication, and most were receiving 3 or fewer agents, with 37%, 13%, and 3% prescribed 2, 3, or 4 or more antihypertensive medications, respectively.

Unadjusted proportions of adherent patients within each AUDIT-C category were calculated for each cohort for both periods (90 days and 1 year). The unadjusted proportions of adherent patients were higher for the 90-day period than for the 1-year period (Figure 2 and Table 2). For both the 90-day and 1-year observation periods, increasing AUDIT-C scores were associated with a trend in decreasing adherence in each medication cohort (statin and hypertension cohort, $P < 0.001$; hypoglycemic cohort at 90 days and 1 year, $P = 0.012$ and $P = 0.022$, respectively), with the adherent proportion decreasing 9% to 15% for statin and antihypertensive cohorts from the nondrinkers to the highest alcohol consumption group.

We did logistic regression analyses separately within each cohort for the 90-day and 1-year periods (Table 2) to produce an adjusted percentage of adherent patients in

Table 1. Patient Characteristics, by Medication Cohort

Characteristic	Statin Cohort (n = 5473)	Oral Hypoglycemic Cohort (n = 3468)	Antihypertensive Treatment Cohort (n = 13 729)
Age, %*			
<50 y	9.9	10.9	12.4
50–59 y	20.4	19.7	18.9
60–69 y	37.8	35.5	33.2
70–79 y	29.6	30.2	31.1
≥80 y	2.3	3.7	4.5
Mean age (SD), y*	64 (9.7)	64 (10.3)	64 (10.9)
Men, %*	97.6	97.9	97.3
White, %†	81.6	74.2	72.9
Married, %‡	66.7	61.3	60.4
High school graduate or above, %†	71.5	69.4	70.6
Positive depression screening, %†	18.0	19.3	19.9
Mean depression screening score (SD)†	12.5 (5.4)	12.7 (5.5)	12.8 (5.54)
Number of other medications used, %§			
0–3	12.6	14.7	21.0
4–5	19.7	21.5	23.1
6–10	44.9	42.3	39.1
≥10	22.8	21.6	16.8
Smoking status, %*			
Never	16.5	20.7	20.1
Former	61.8	60	57.0
Current	21.8	19.3	22.9
Alcohol misuse group, %§			
Nondrinker (AUDIT-C score, 0)	49.3	56.7	47.4
Low-level use (AUDIT-C score, 1–3)	32.0	29.9	30.2
Mild alcohol misuse (AUDIT-C score, 4–5)	11.3	6.9	11.1
Moderate alcohol misuse (AUDIT-C score, 6–7)	4.3	3.1	5.5
Severe alcohol misuse (AUDIT-C score, 8–12)	3.2	3.3	5.8

AUDIT-C = Alcohol Use Disorder Identification Test–Consumption. * Maximum level of missing data in covariate was approximately <1%. † Maximum level of missing data in covariate was approximately <5%. ‡ Maximum level of missing data in covariate was approximately <3%. § No missing data.

each AUDIT-C category that accounts for confounding factors. Among statin users, during the 90-day observation period, patients with AUDIT-C scores of 8 or more were less adherent to statins than nondrinkers (adjusted difference, -8 percentage points [95% CI, -1 to -15 percentage points]) after adjustment for age, sex, race, marital status, education, total number of oral medications, smoking status, and depression screening score. During the 1-year follow-up, in demographically adjusted models all levels of alcohol use and misuse had significantly lower percentages of patients who were adherent to statins compared with nondrinkers. After full adjustment, the 2 highest levels of alcohol misuse with AUDIT-C scores of 6 or more were associated with lower adherence than nondrinkers. In most models of adherence to statins for both the 90-day and 1-year observation periods, there was a statistically significant trend in decreasing adherence with increasing degrees of alcohol misuse as measured by AUDIT-C scores, except in the fully adjusted, 90-day analysis.

In the oral hypoglycemic cohort, individual categories of AUDIT-C scores were not associated with statistically significant changes in adherence to these oral medications in adjusted analyses. Although there was a statistically significant trend in point estimates toward decreased adherence with higher AUDIT-C scores in unadjusted analyses, no statistically significant trend was observed after adjustment.

Results of regression analyses for adherence to anti-hypertensive medications were similar to results for statins. In fully adjusted models for the 90-day period, approximately 5% fewer patients with AUDIT-C scores of 6 or more were classified as adherent compared with nondrinkers ($P = 0.003$ for AUDIT-C score of 6 to 7; $P < 0.001$ for AUDIT-C score ≥ 8). During the 1-year observation period, all levels of alcohol misuse corresponding to AUDIT-C scores of 4 or more were associated with decreased adherence in fully adjusted models. Progressively higher levels of misuse, as measured by AUDIT-C scores of 4 to 5, 6 to 7, and 8 or more, were associated with approximately 3% ($P = 0.029$), 4% ($P = 0.038$), and 8% ($P < 0.001$) fewer patients, respectively, classified as adherent ($P < 0.001$ for trend). In all hypertension cohort models for both periods, there was a significant trend toward decreased adherence with higher AUDIT-C categories.

DISCUSSION

Our study shows that nonadherence to medications for hyperlipidemia and hypertension was associated with alcohol misuse, as measured by a brief, scaled alcohol screening questionnaire. We found a graded, linear decrease in medication adherence to statins and hypertension medications with increasing levels of alcohol misuse as measured by the AUDIT-C. Moreover, the association was similar for adherence during both 90 days and 1 year of follow-up. The difference in adherence to statin and anti-

hypertensive medications was clinically significant, with 5% to 10% fewer patients in the highest AUDIT-C category (score range, 8 to 12) classified as adherent than in the nondrinker category. In contrast, adherence to oral hypoglycemics among diabetic patients was not associated with AUDIT-C scores after adjustment for important covariates.

Several mechanisms may underlie this association. Even periodic mild intoxication may cause patients who intend to take prescribed medications to forget to take or refill them. In addition, patients with higher AUDIT-C scores may consciously forgo medications because they are concerned about how medications may interact with alcohol, do not want to or cannot pay the nominal copayment for medications, or are less concerned about the effects of missing prescribed medications.

A comprehensive search of the literature for the keywords *medication adherence*, *alcohol*, *medication compliance*, *drinking*, and combinations thereof suggests that research through 2008 on the association of alcohol misuse and medication adherence has come largely from studies of patients with HIV or diabetes. The Veterans Aging Cohort Study investigators examined the association between self-reported daily adherence to all medications and an in-depth measure of alcohol consumption, the Alcohol Timeline Followback, among patients with HIV and matched control participants without HIV (8). Among patients who reported never drinking 5 or more drinks per occasion

Figure 2. Proportion of adherent patients, by Alcohol Use Disorder Identification Test–Consumption (AUDIT-C) score and days in observation period.

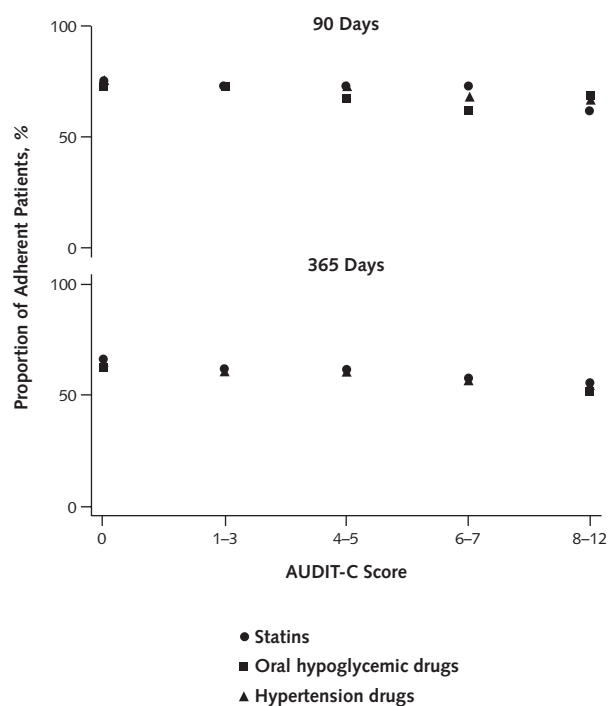


Table 2. Association between the Proportion of Patients Adherent to Medication for More Than 80% of a 90-Day or 1-Year Period and Alcohol Misuse as Measured by the Alcohol Use Disorder Identification Test–Consumption (AUDIT-C)

Variable	90-Day Adherence			1-Year Adherence		
	Unadjusted Proportion (95% CI)	Demographic Characteristics–Adjusted Proportion (95% CI)*	Fully Adjusted Proportion (95% CI)†	Unadjusted Proportion (95% CI)	Demographic Characteristics–Adjusted Proportion (95% CI)*	Fully Adjusted Proportion (95% CI)†
Statin cohort						
Patients, n‡	5473	5105	4989	5473	5105	4989
AUDIT-C score§						
0	75 (74–77)	76 (74–77)	75 (73–77)	66 (64–68)	66 (64–68)	66 (64–68)
1–3	73 (71–75)	73 (71–75)	74 (72–76)	62 (60–64)	62 (60–64)	63 (60–65)
4–5	73 (69–76)	73 (69–76)	74 (70–77)	61 (58–65)	62 (58–66)	63 (59–67)
6–7	73 (66–78)	75 (69–80)	75 (69–81)	56 (49–62)	58 (51–64)	58 (52–65)
8–12	62 (54–69)	65 (57–72)	67 (59–74)	51 (44–59)	54 (46–61)	55 (47–63)
P value for trend	<0.001	0.009	0.082	<0.001	<0.001	0.001
Oral hypoglycemic cohort						
Patients, n‡	3468	3228	3114	3468	3228	3114
AUDIT-C score§						
0	73 (71–75)	72 (70–75)	73 (71–75)	63 (61–65)	63 (61–65)	63 (61–65)
1–3	73 (70–75)	73 (70–76)	73 (70–76)	60 (57–63)	60 (57–63)	60 (57–63)
4–5	68 (61–73)	68 (62–74)	69 (62–74)	61 (55–67)	62 (56–68)	63 (57–70)
6–7	62 (53–71)	67 (57–75)	67 (57–75)	57 (48–66)	60 (50–69)	61 (51–70)
8–12	68 (59–76)	69 (60–77)	69 (60–77)	55 (46–64)	57 (47–66)	58 (48–67)
P value for trend	0.012	0.139	0.150	0.022	0.129	0.25
Hypertension treatment cohort						
Patients, n‡	13 729	12 858	12 545	13 729	12 858	12 545
AUDIT-C score§						
0	75 (74–76)	75 (74–76)	75 (74–76)	64 (63–65)	64 (63–65)	64 (63–65)
1–3	73 (72–75)	73 (72–75)	73 (72–75)	62 (61–64)	62 (61–64)	62 (61–64)
4–5	73 (70–75)	73 (71–75)	74 (71–76)	60 (57–62)	61 (58–63)	61 (58–64)
6–7	68 (64–71)	70 (66–73)	70 (67–74)	56 (52–59)	59 (55–62)	60 (56–63)
8–12	66 (63–70)	68 (64–71)	69 (65–72)	53 (49–56)	55 (51–58)	56 (52–60)
P value for trend	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

* Adjusted for age, sex, race, marital status, and education.

† Adjusted for demographic characteristics, oral medication count, smoking, and depression score.

‡ Number of patients in regression models varies because of missing covariates.

§ AUDIT-C categories correspond to nondrinkers (score, 0); low-level alcohol use (score range, 1–3); and mild (score range, 4–5), moderate (score range, 6–7), and severe (score range, 8–12) alcohol misuse.

|| P < 0.05 compared with an AUDIT-C score of 0 (nondrinkers).

(non-binge drinkers), HIV-positive patients were 1.6 times more likely to classify themselves as nonadherent on drinking days than on nondrinking days, whereas among binge drinkers, both HIV-positive and HIV-negative patients were approximately 4 times more likely in adjusted analyses to self-report medication nonadherence when they reported drinking. Other smaller studies of HIV-positive patients had similar findings (9–11, 31). Efforts to improve medication adherence among HIV-positive patients by addressing alcohol use or misuse have had mixed results (32–34). Among more than 65 000 diabetic patients in an HMO study, the predicted probability of adherence to hypoglycemic medications for 80% of days or more decreased as alcohol consumption increased (12). Two other smaller studies, 1 of refill adherence among patients older than age 65 years (3) and the other of self-reported adherence among inner-city patients (13), found decreased adherence among patients who reported drinking any alcohol. Alco-

hol use has also been associated with decreased adherence to dermatologic (35, 36) and asthma medications (37).

To our knowledge, only 1 previous study has evaluated the association between scores on a clinically practical, validated alcohol screening questionnaire and medication adherence. This previous study of 212 HIV-infected patients evaluated the association between the 10-item AUDIT score and self-reported medication adherence for all medications the patient was prescribed. Patients with an AUDIT score of 8 or more (out of 40 possible points) were 2.6 times more likely to report taking doses off schedule or missing a dose than were nondrinkers (9). Women who reported drinking more than 12 drinks per week and men who reported drinking 16 drinks per week tended to be more likely to self-report lower medication adherence, but these results were not statistically significant (9). Among elderly patients receiving home care, self-reported medication adherence was associated with a non-validated screening for problem drinking (38), and a study of

VA patients with bipolar disorder found an association between AUDIT question 2 and self-report of 2 or more barriers to medication adherence (39).

Our study adds to this previous literature in several important ways. To our knowledge, ours is the first study to show that a validated, practical alcohol screening questionnaire can identify patients with alcohol misuse who are at risk for poor medication adherence, independent of demographic and other clinical risk factors, including number of total medications and a measure of depressive symptomatology. Consistent with findings in studies of alcohol use and medication adherence (8), the association with the scaled AUDIT-C score seems to reflect a dose–response relationship between alcohol misuse and medication adherence, which in turn suggests that brief interventions that lead to decreased drinking might improve medication adherence. The National Commission on Prevention Priorities recently ranked brief alcohol interventions the third most important preventive practice among those recommended by the U.S. Preventive Services Task Force (40). Addressing alcohol misuse may therefore be an important approach to improving medication adherence.

This study has several important limitations. First, although the AUDIT-C is a widely used screening tool in clinical practice (41, 42), we used AUDIT-C scores from mailed surveys, which tend to be higher than AUDIT-C scores recorded in medical records (43). However, what effect this may have had on the association between AUDIT-C scores and medication adherence is not clear. Second, pharmacy-based refill measures of medication adherence, such as the one we used, do not capture nonadherence if patients obtain but do not take their medications. Patients may also have obtained medications from outside the VA, although during our study VA medications were available for nominal copayment. However, pharmacy-based adherence measures are widely used and are not limited by recall or social desirability biases like self-report measures. Furthermore, the measure we used correlates with physiologic outcomes in VA outpatients (27). Third, the commonly used definition of medication adherence in this study was relatively liberal. Patients were considered nonadherent if they did not have medications for at least 18 days in a 90-day period or at least 73 days in a 1-year period. Fourth, there was a trend among patients taking oral hypoglycemic medications toward decreasing adherence with increasing alcohol use, but this association was not significant after adjustment. It is possible that the smaller sample of diabetic patients, the smaller proportion with high AUDIT-C scores, and the slightly lower overall prevalence of adherence in this group prevented us from detecting an association because of insufficient statistical power. Alternatively, our finding may have differed from findings of previous studies (12) because we adjusted for depression by using a validated screening test. Fifth, patients with heavier alcohol consumption may have transferred out of VA care at a higher rate than those with lower

levels of consumption. This would tend to increase or even create the observed effect between refill adherence and AUDIT-C. We attempted to address such bias by including participants who were actively receiving care from a VA general medicine clinic, returned relevant surveys, and had at least 1 of the qualifying medication fills during the year of observation after the response on the AUDIT-C. Furthermore, although requiring a fill during the year of follow-up could have biased the 1-year adherence measure upward, we partially addressed this by including measures of 90-day adherence. Finally, most of the sample was older white men, potentially limiting the generalizability of results. However, the sample is also a major strength of this study. Few studies of older patients, who take the most medications, include large numbers of patients who drink at high levels, whereas this study included 2164 patients with AUDIT-C scores of 8 to 12, most of whom drink 4 or more drinks on drinking days.

Medication nonadherence has been shown to be a pervasive and persistent problem, and few interventions have proven to be widely effective at improving adherence. This study demonstrated that alcohol misuse is a possible risk factor for lower medication adherence among patients taking common medications. Moreover, the measure of alcohol misuse is a practical 3-item alcohol screening questionnaire that is increasingly used for routine screening in large health care systems (42). Because research has shown that brief counseling interventions decrease drinking (6), intervention studies are needed to assess whether brief counseling that leads to decreased drinking will also improve medication adherence. In the meantime, this study adds to the already strong evidence (44) for the potential medical relevance of routine alcohol screening in medical settings.

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AD LIBITUM

Untitled

Light through mountains made me realize why the house's previous owner blew the brains out of his thyroid cancer at seven AM.

In the dead of winter—

Winter was warm and alive and chirping the entire time I was there—

The day began as shines, lighter cuts in the blue fabric gently dressing the silhouetted mountains.

Everything was there—the musk of eucalyptus peppered with early morning chill—

A little piece of cold, like gazpacho for breakfast—the black birds of red-patched wings singing, or at least taking stage in the trees to claim credit for some unseen avian pit orchestra—

And then the breaking border of glorious yellow light from between the peaks, shining in an arc instantaneously under the earthen border at the same time, as is the particular propagative nature of these beams hailing the beginning of our days—

days we emerge as little shirtless sunflowers.

So when the evening begins to set and the day slowly gluts off our petals, like that one kid who always tore the wings from butterflies and the legs from grasshoppers,

Why shouldn't the pistils bring the glowing green backlash to its crisis and bring the stars down upon hypoxic tissue with the fury of a split Picardy? No surprise, then, when that crack ripped through the yard and its fallen petals and bone and brain and time.

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